# A BRIEF, SELECTIVE REVIEW OF THERMAL CYCLING FATIGUE IN EUTECTIC TIN-LEAD SOLDER

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For many decades it has been known that the mechanical strength of solders, including in particular eutectic Sn-Pb solder, is subject to failure under environments containing mechanical stresses. In early electronic systems, such failures were avoided primarily by not using solder as mechanical structural components. The rule was first to make mechanically sound wiring connections, and only then to solder them.

With miniaturization resulting from modern solid state electronic components, including the use of Printed Wiring Boards (PWBS), the old rule of thumb has gone by the board. Careful design of modern electronic systems has limited the mechanical stresses exerted on solder joints to values within their yield points, and these joints have become integral parts of the mechanical structures. This has been especially true in circuitry intended for use in spacecraft, where the premium on reduction of mass is especially high.

Unfortunately, while these joints have proved strong enough to survive when new, they have proved vulnerable to fatigue failures as they age. These fatigue failures have limited the useful lifetimes of their circuits to values which, especially in the case of long mission spacecraft, are undesirably small.

This paper reviews selected parts of the current literature relevant to thermo-mechanical fatigue mechanisms in eutectic Sn-Pb solder, and suggests a general outline to account for some observed failures. The field is found to be complex. One recent experimental study finds some failure modes to be sensitive to joint geometry. Attempts to extrapolate from test environments to service environments have had only limited success. Much work remains to be done before fatigue failures in this material can be considered as under practical control.